Space Weather Technical Forecast

Issued on Sunday, 04 February 2024 at 13:17 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely throughout, with a slight chance of X-class flares. Chance of G1 Sunday 04 February due to possible glancing blow from a CME combining with coronal hole fast wind arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured by GOES16, has been Moderate, with the peak flare in the last 24 hours a M1.4 at 04/1153UTC from AR3576. There are currently eight numbered sunspots on the visible disc and one new unnumbered spot. AR3575 remains the largest and most magnetically complex, contains a delta spot, and has continued to show some minor growth in recent hours. The newly numbered AR3576 continues to emerge from around the southeast limb. This has been classified as an Dac/Beta configuration at present, although this region remains difficult to ascertain an accurate analysis due to foreshortening. The new unnumbered spot is small and simple. All other spots have remained fairly stable or have decreased in size. No Earth-directed CMEs have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, were reflective of a slow-ambient solar wind regime for the majority of the period, with solar wind speed at background levels, between 300-320km/s and solar wind density predominantly average or below. The IMF was weak for most of the period, at or below 6nT, while the north-south component ranged between -5 and +5nT. The phi angle was mostly negative (away from the Sun) until 04/0300UTC, when there was an abrupt change to mostly negative (towards the Sun).

Since approximately 04/1015UTC there has been a change in solar wind measures, with an increase in speed to slightly elevated levels around 400km/s, more variable density (though still average or below) and more moderate IMF around 10nT, with the north-south component rising to 9nT. Phi angle has recently changed to positive (towards the Sun). This may be due to a glancing blow from a CME, or interaction with a HSS but this is still uncertain.

The net result of the above solar wind measures was provisionally Quiet (Kp0-1) geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is currently slightly elevated above Background levels following the M6.8 flare on 29 Jan from Ex-AR3559, but remains well below the S1/Minor Radiation Storm threshold.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. At 04/0001UTC the 24-hour integrated fluence observation was 7e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Overall activity is most likely to be Moderate, with isolated M-class flares likely and a slight chance of an X-class flare, most likely from AR3575 in the southwest, but also from AR3576 emerging on the southeast limb.

Solar Wind / Geomagnetic Activity: A CME that left the Sun at 01/0743UTC may be delivering a glancing blow at the time of writing, or may be yet to arrive. There may be also be a fast wind

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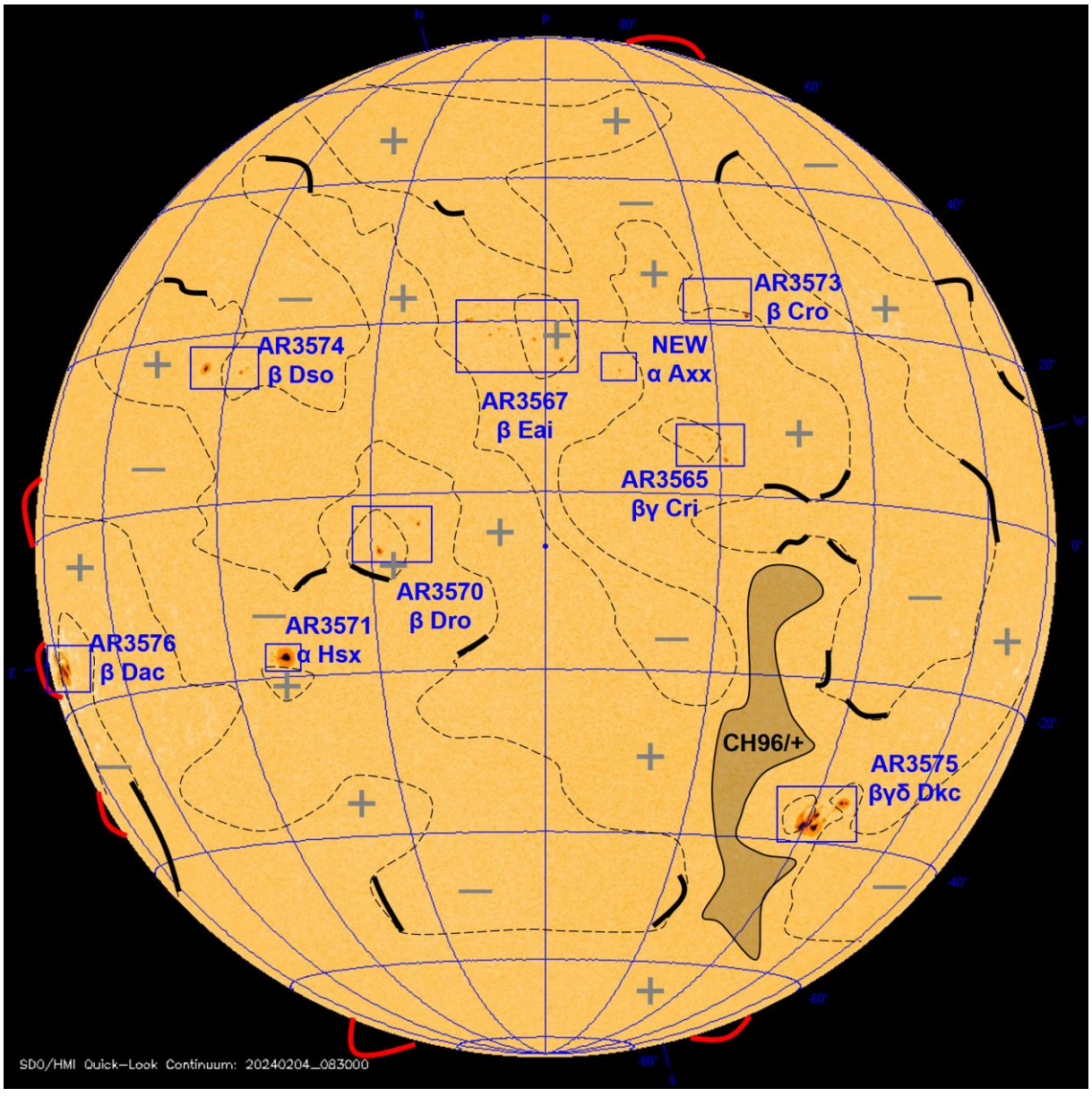
enhancement from CH96/+ during this period. Geomagnetic activity is expected to be mostly Quiet through the period, but perhaps a chance of G1/minor storm should any CIR leading the fast wind from CH96/+ combine with glancing CME effects on day 1 (04 February).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain below the S1/Minor Radiation Storm level, with a daily slight chance of exceeding the S1 threshold during the period.

The high energy electron flux (greater than 2MeV) is expected to remain below High levels throughout the period, with exceedance of the Active fluence threshold considered unlikely.

Figure 1. Solar Analysis Valid 04/0830UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which originated from a long-period C3 flare at 01/0743UTC near north-centre disc, may be delivering a glancing blow at the time of writing, or may be yet to arrive. This is the only CME that features in the forecast at present.

In addition to the CME contribution to the geomagnetic forecast, there may be also be a fast wind enhancement from CH96/+ in the southern solar hemisphere during this period. The majority of the HSS arrival is expected to straddle the UTC days of 04 and 05 February with solar wind speeds perhaps reaching 450-500 km/s. However, on the previous rotation, wind speeds barely reached 450 km/s with little geomagnetic response. At this time of year any response to positive polarity coronal holes is expected to be muted.

Geomagnetic activity is expected to be mostly Quiet through the period, but perhaps a chance of G1/minor storm should any CIR leading the fast wind from CH96/+ combine with glancing CME effects on day 1 (04 February).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	25	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1245	Partial	Plage area	NE	720km/s	04/0600UTC	Glancing blow possible. May have recently occurred.

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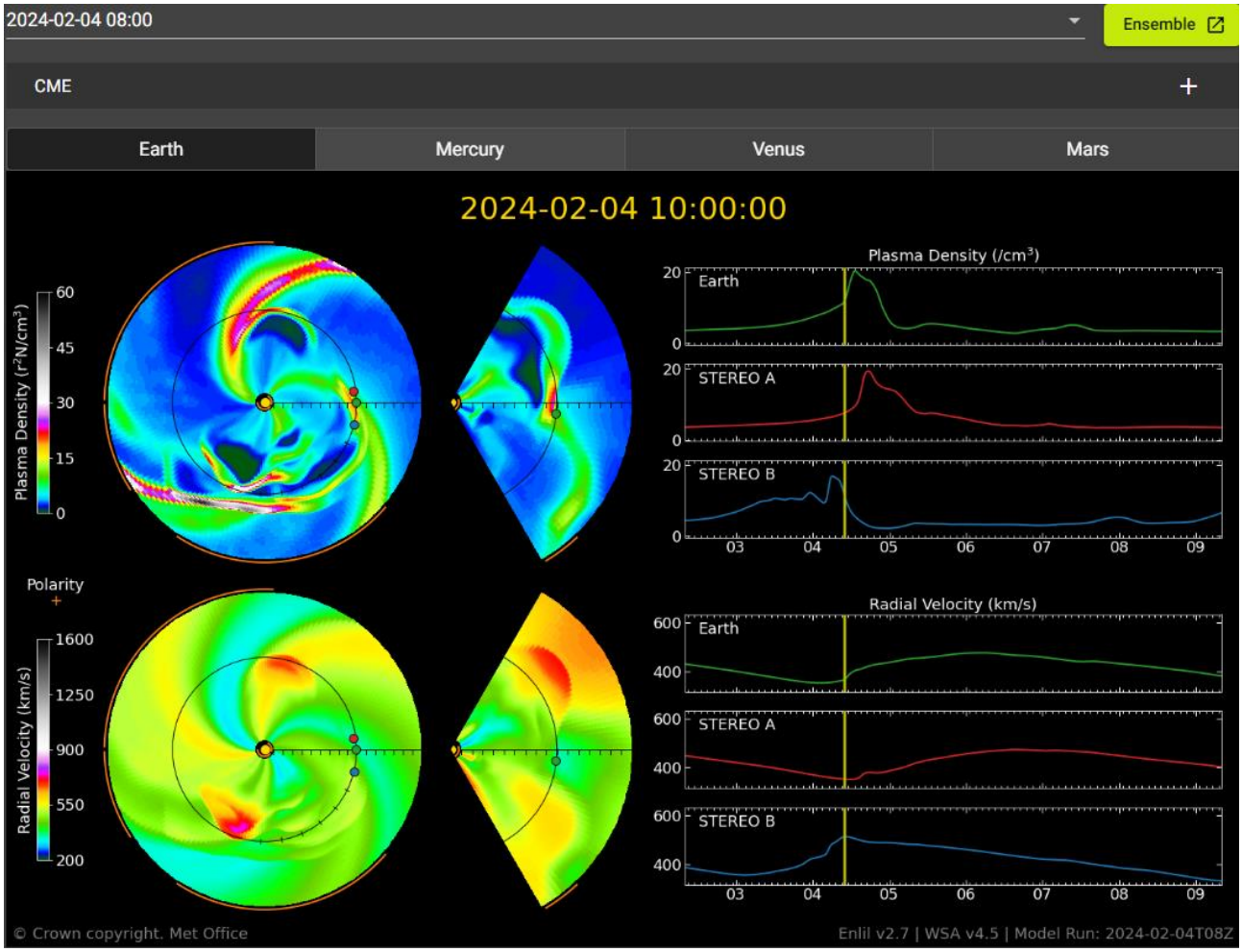
Figure 2: MOSWOC ENLIL showing a glancing blow from CME combining with HSS from CH96/+. This may be already occurring, but analysis is ongoing.



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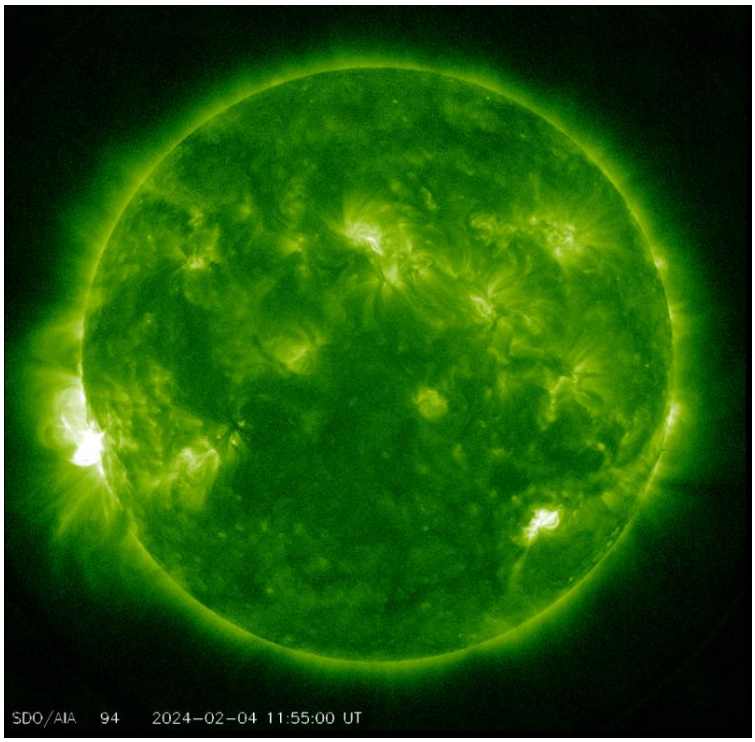
Radio Blackouts - X-Ray Flares:

There are currently eight numbered sunspots on the visible disc, and one unnumbered. AR3575 has continued to grow over the last day, becoming more compact and magnetically complex, and contains a delta spot. There is a chance of AR3575 producing M-class flares, with a slight chance of an X-flare, given its complexity. AR3576 has emerged on the southeast limb over the last 24 hours, and looks large and relatively complex too, although this is currently difficult to analyse due to foreshortening. SDO/AIA 94 imagery shows an increase in the bright flux associated with this new region, as does SDO 171, with significant magnetic looping observed. The new unnumbered region is small and simple. All other spots have remained fairly stable or have decreased in size.

None of the current regions are expected to rotate off the disc until after Day 4 (07 February) and there is no evidence for any more large regions rotating over the eastern limb, so M-class flares remain likely throughout, with a slight chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: SDO/AIA 94 showing bright flux and flaring associated with the recent M1.4 flare from AR3576.



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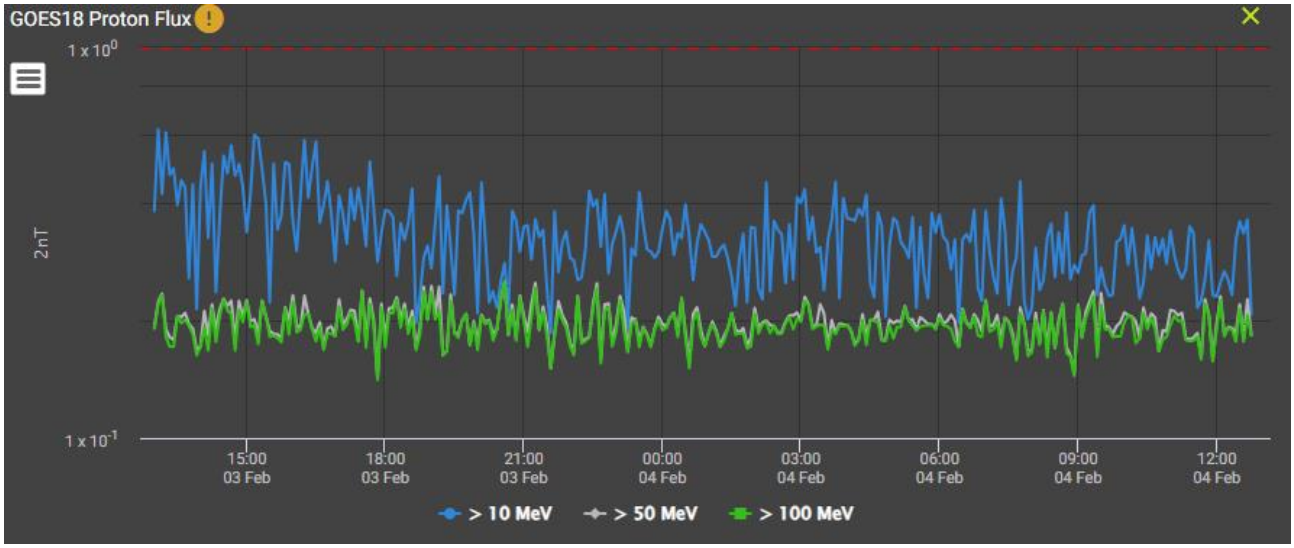
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux remains a little above Background levels following the M6.8 flare on 29 Jan from Ex-AR3559, but remains well below the S1/Minor Radiation Storm threshold.

There remains a slight chance of reaching S1 levels should any of the regions on the disc produce any larger flares. The rapid growth and complexity of AR3575 make it the most likely region to produce a proton storm, particularly as continues to rotate into the favourable western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton Flux



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been mostly at Background levels. Any CME or HSS effects during this period are most likely to be fairly weak, and lack impetus for a significant increase in electron flux. There is a very low risk of an increase later in the period, should there be a stronger response to the CME or inbound fast wind than expected.

Overall, the electron fluence is expected to remain well below the Active (1e8 integrated flux) threshold, perhaps with a slight rising trend later in the period. MOSWOC REFM's projections are currently underestimating the fluence, but still the overall below-Active trend is thought to be a good guide.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES16 Electron Flux (top) and MOSWOC REFM (bottom)

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